

# DOE / SNL Scaled Wind Farm Technology (SWiFT) Facility at TTU

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# ***Outline***

- ***DOE/SNL Objectives of Scaled Wind Farm Technology Facility***
- ***SWIFT Overview***
- ***Collaborative Partnerships***
- ***Progress Updates***



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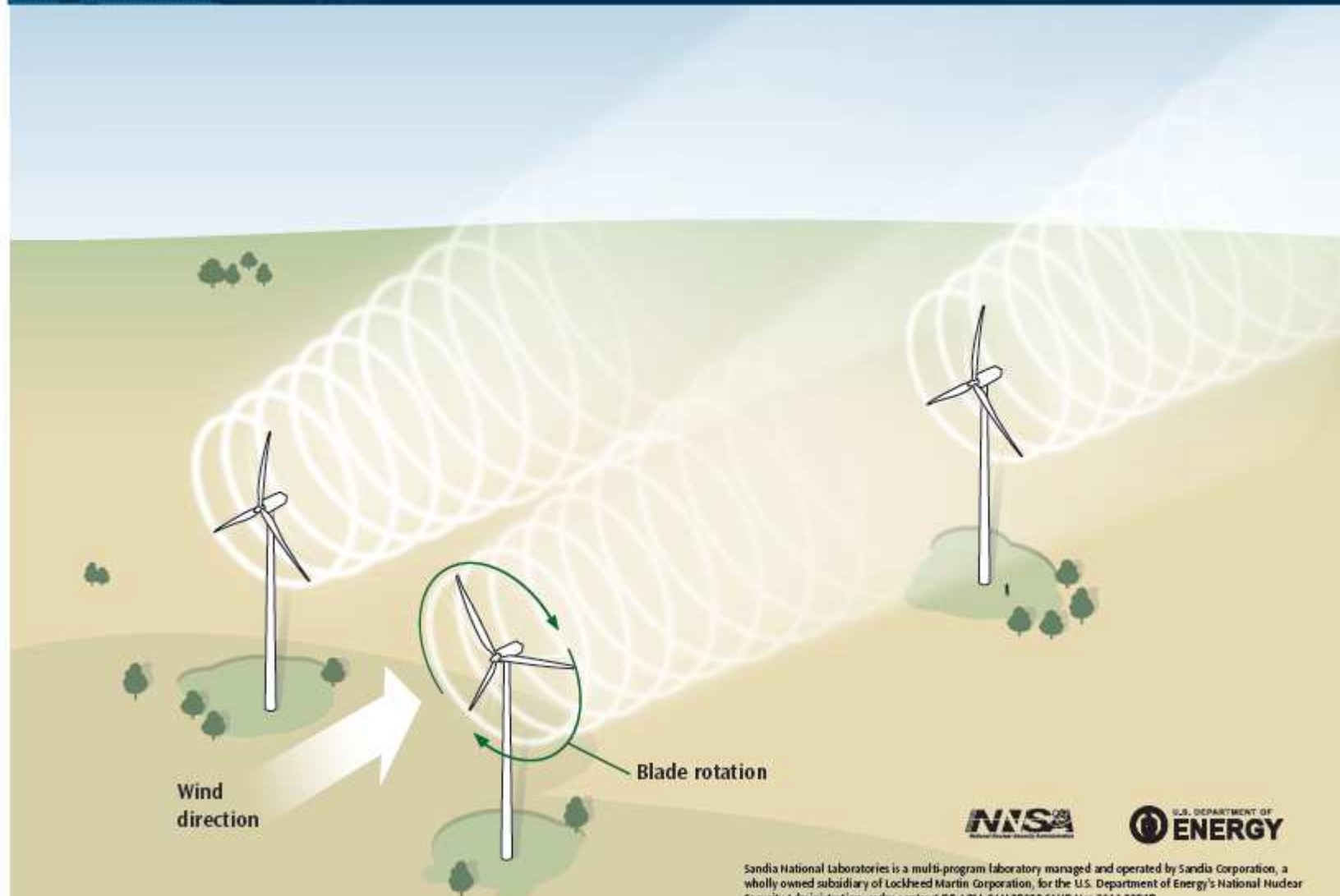


# ***DOE/SNL Objectives of Scaled Wind Farm Technology Facility***



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*Exceptional service in the national interest*



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# DOE/SNL Objectives

## ■ **Study of turbine to turbine interaction**

- *Tip vortices, wake growth, wake mixing, meandering wakes*
- *Inflow turbulence, low-level jets, advanced features*

## ■ **Advanced wind turbine rotor development**

- *Passive load control: bend-twist coupling, sweep-twist coupling, passive camber control, flat-back airfoils*
- *Active load control: smart rotor, nonlinear wind turbine control, smart turbine design*
- *Advanced sensing technologies: operational monitoring, structural health monitoring, prognostics*

## ■ **Aerodynamics, aero-elasticity, and aero-acoustics testbed**

- *Inboard aerodynamics, 3D blade flow, NUMAD / BPE design tool advancement, near-blade acoustic generation, acoustic propagation, acoustic beam-forming*





# ***SWIFT Overview***

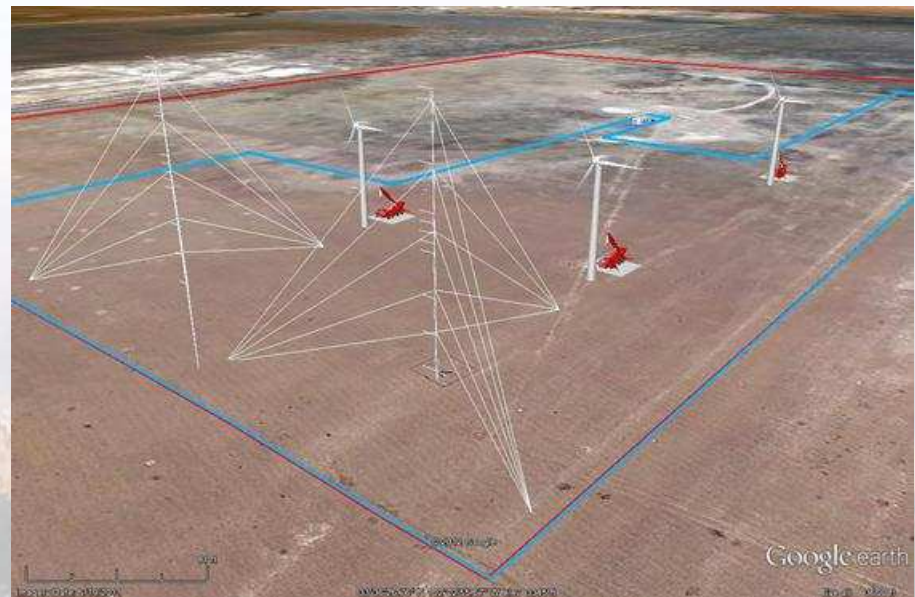
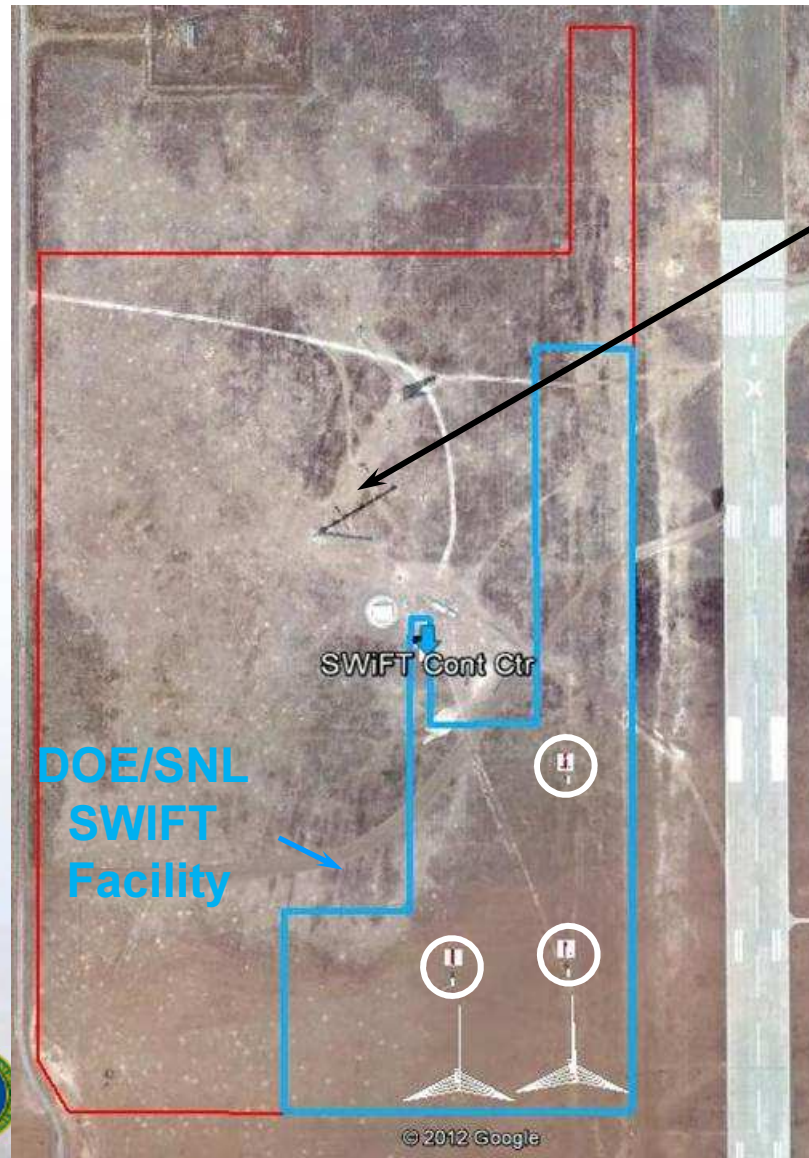


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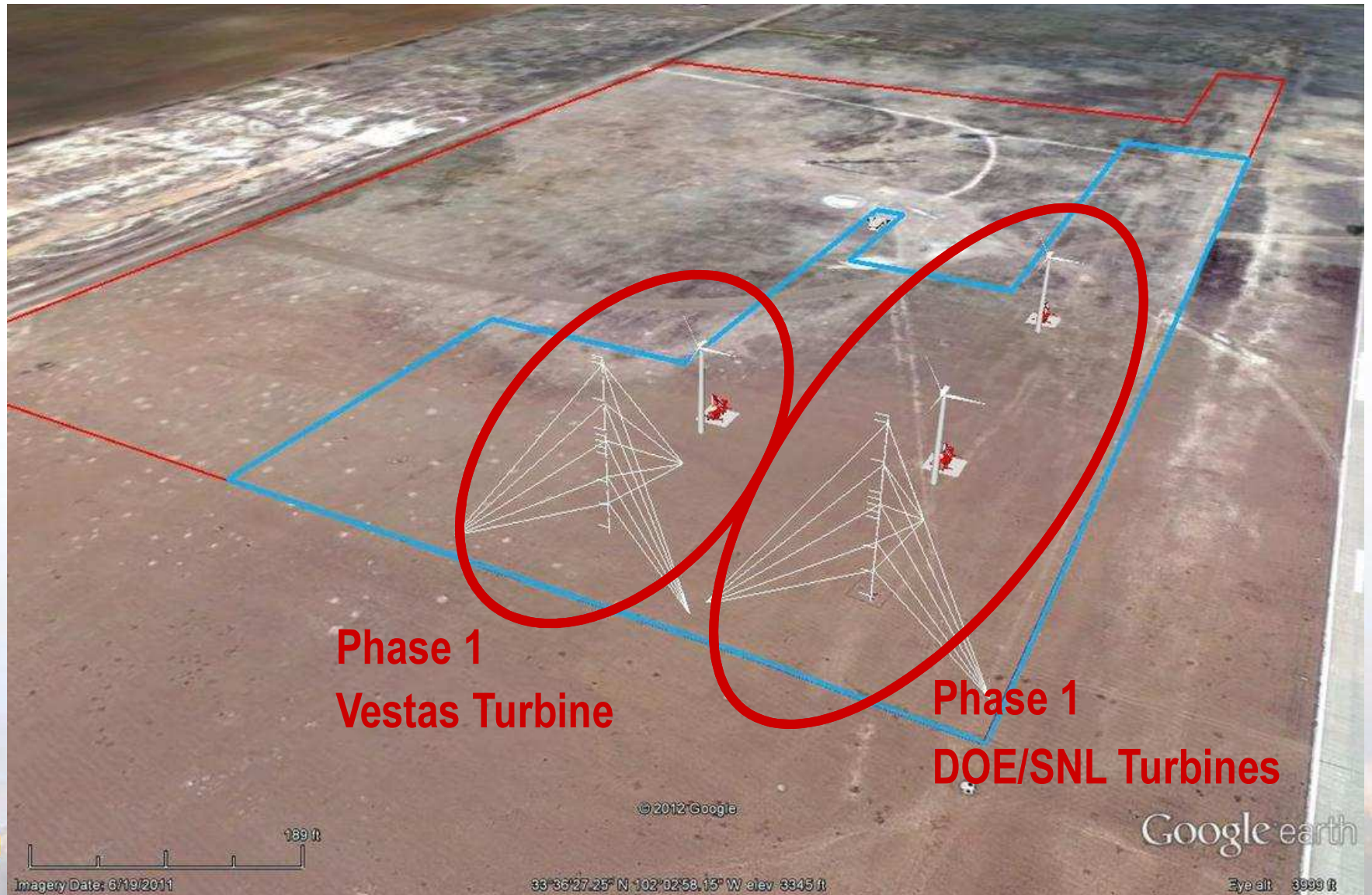
# Site Plan



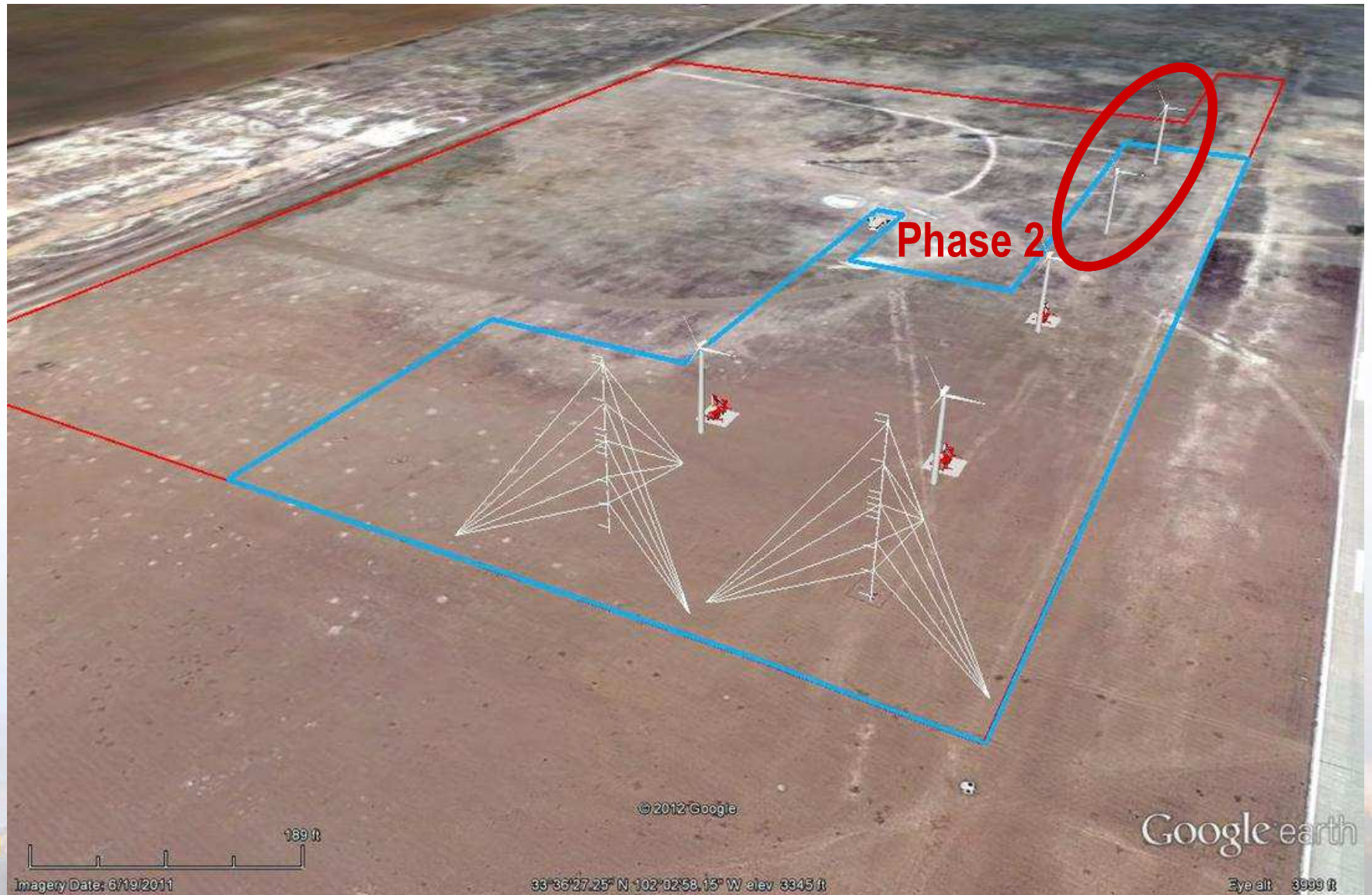
# ***Turbine Site Plan***



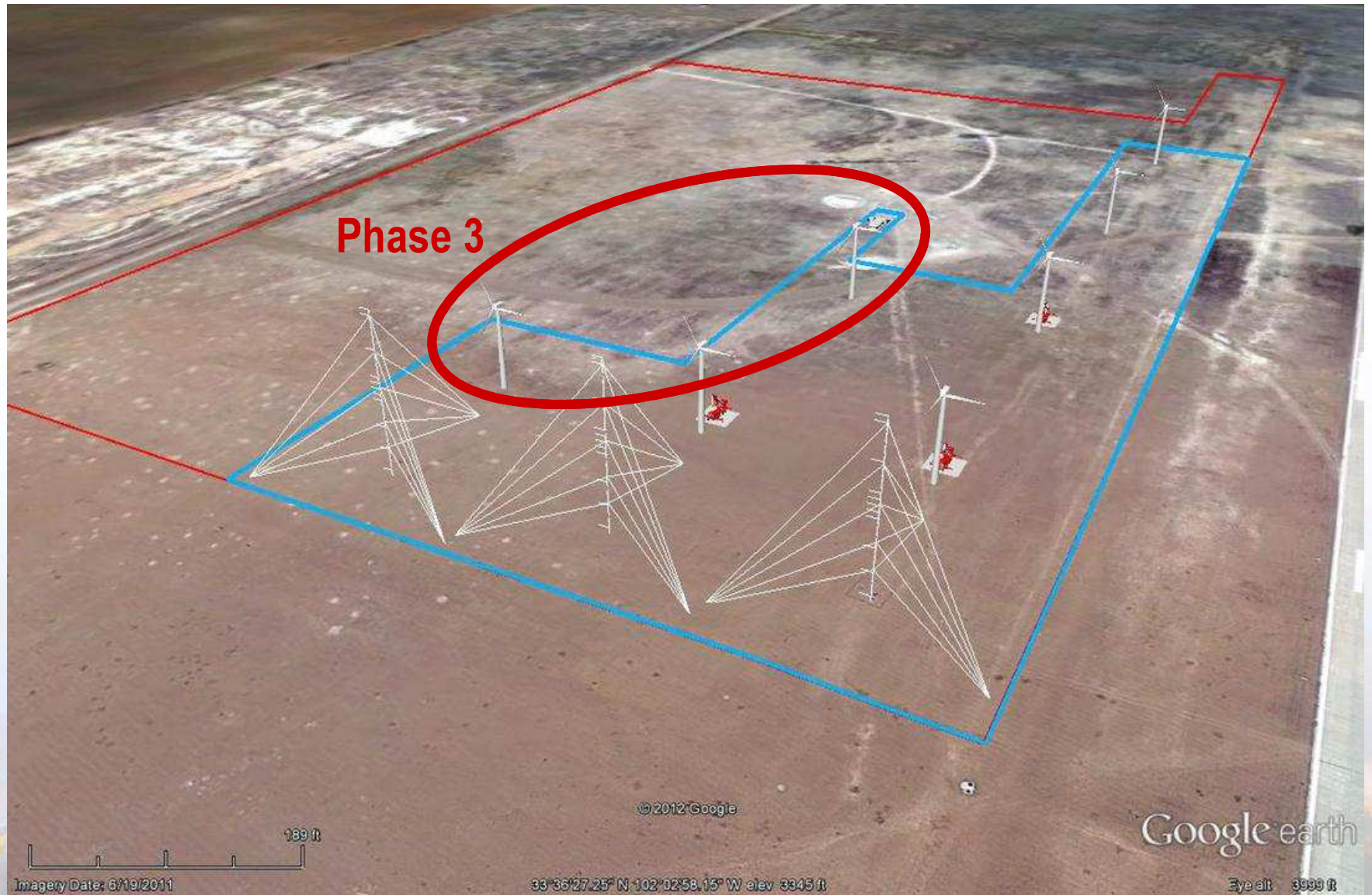
# ***SWIFT Array Long-Term Plan***



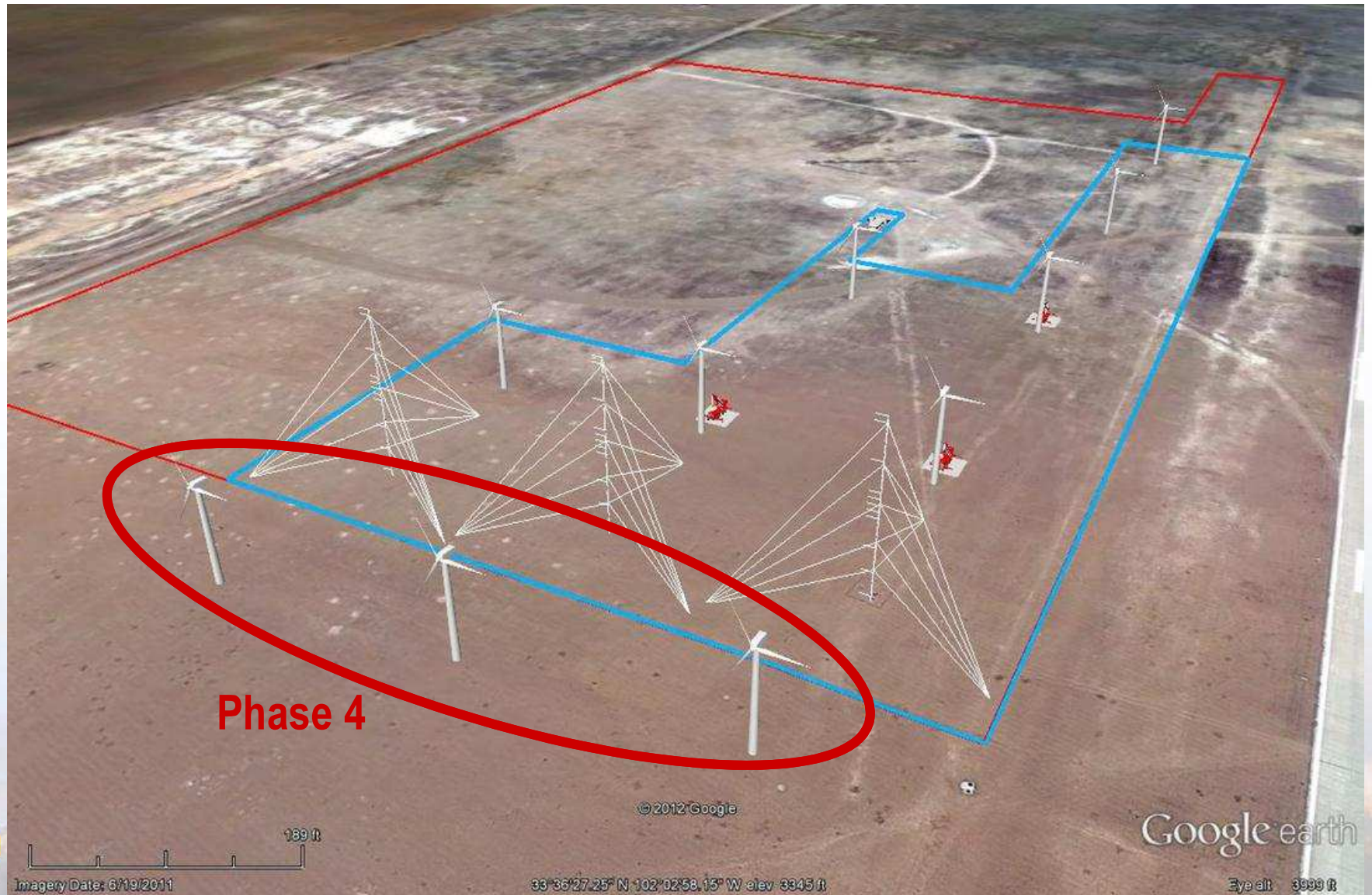
# ***SWIFT Array Long-Term Plan***



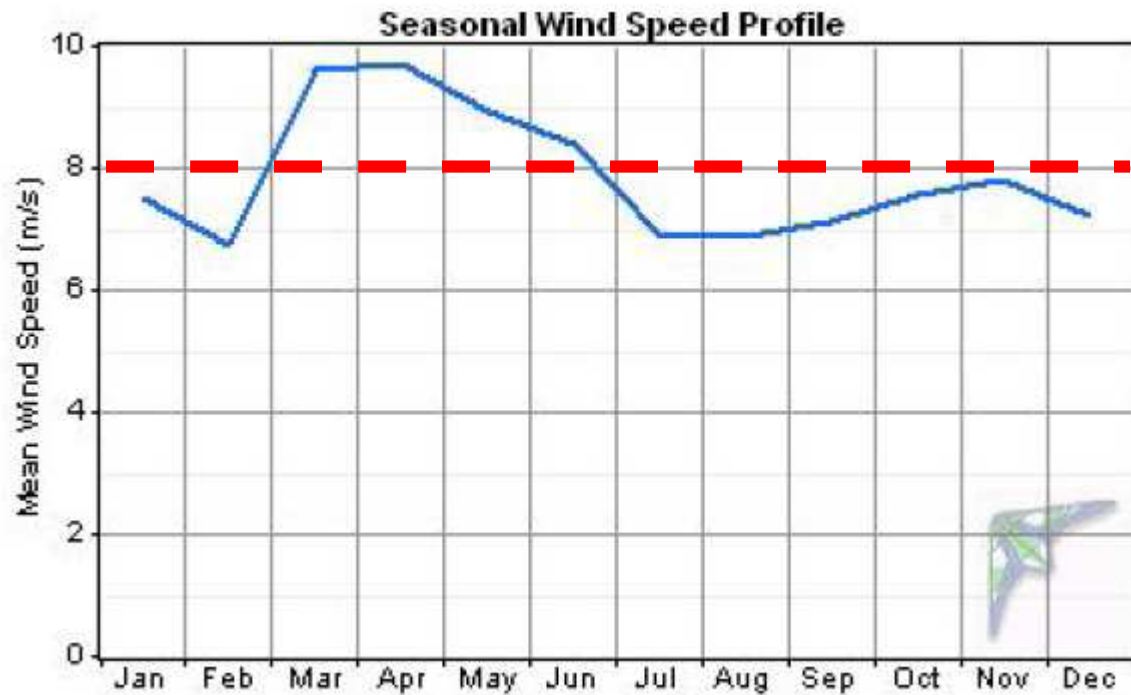
# ***SWIFT Array Long-Term Plan***



# ***SWIFT Array Long-Term Plan***

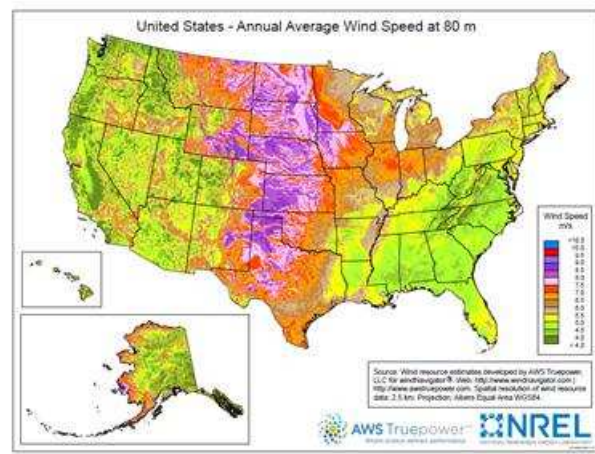


# Wind Resource Assessment

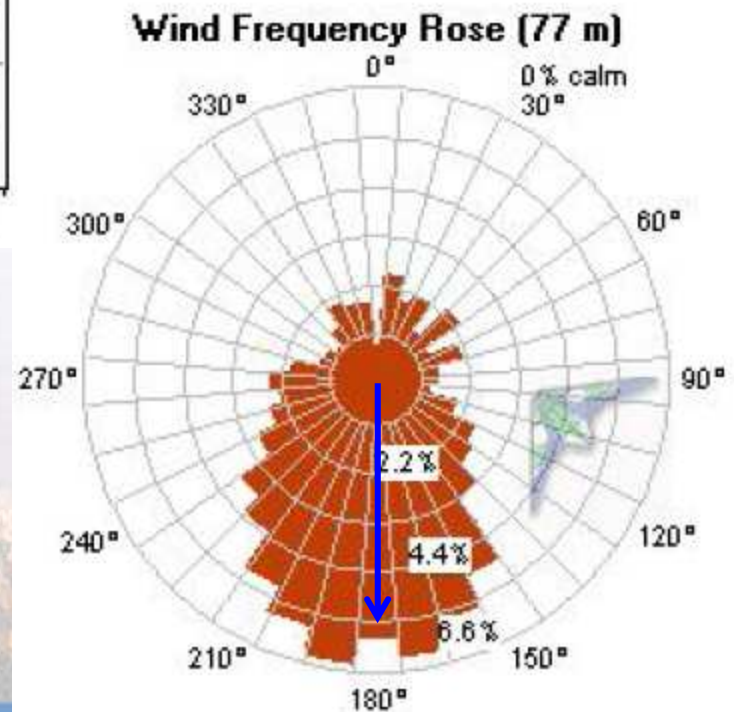


**8 m/s at 77 m  
(7.5 m/s at 50 m)**

**Class 5 Wind Site!**



**Consistent Wind  
South  
180.5° Average**



# Proposed Test Turbine

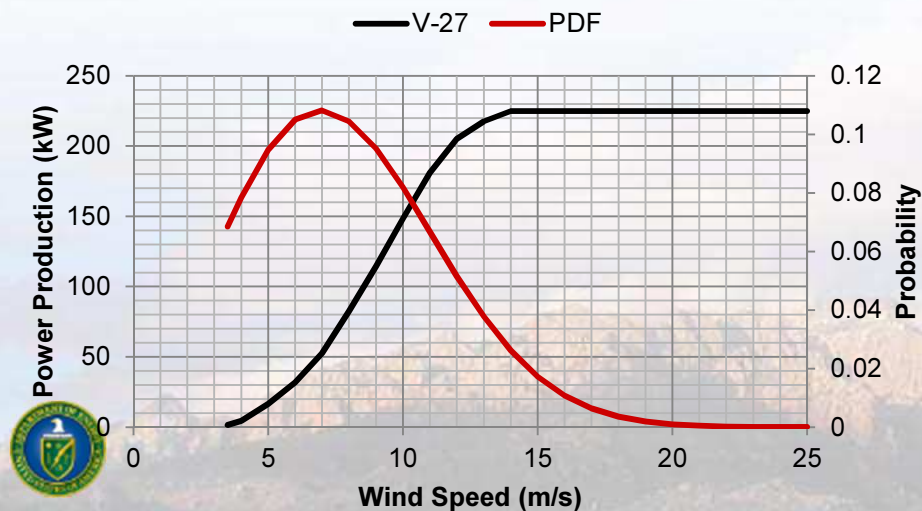


## Modified Vestas V-27

- 300 kW (0 – 55 rpm)
- 13 m (43 ft) Blade Length
- Pitch Control in Region 3
- 30 m (98 ft) Tower Height
- Reynolds Number  $\sim 2 \times 10^6$
- Highly reliable

## Site Production

- 7 m/s hub-ht. average
- 92 kW Average
- 41% Capacity Factor

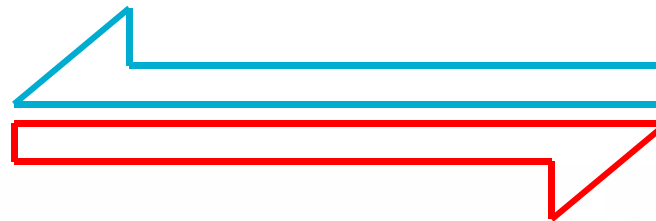


# What is Research-Scale?

Research-Scale



*Minimum research  
cost and time*



*Exact  
Scaling*

Megawatt-Scale

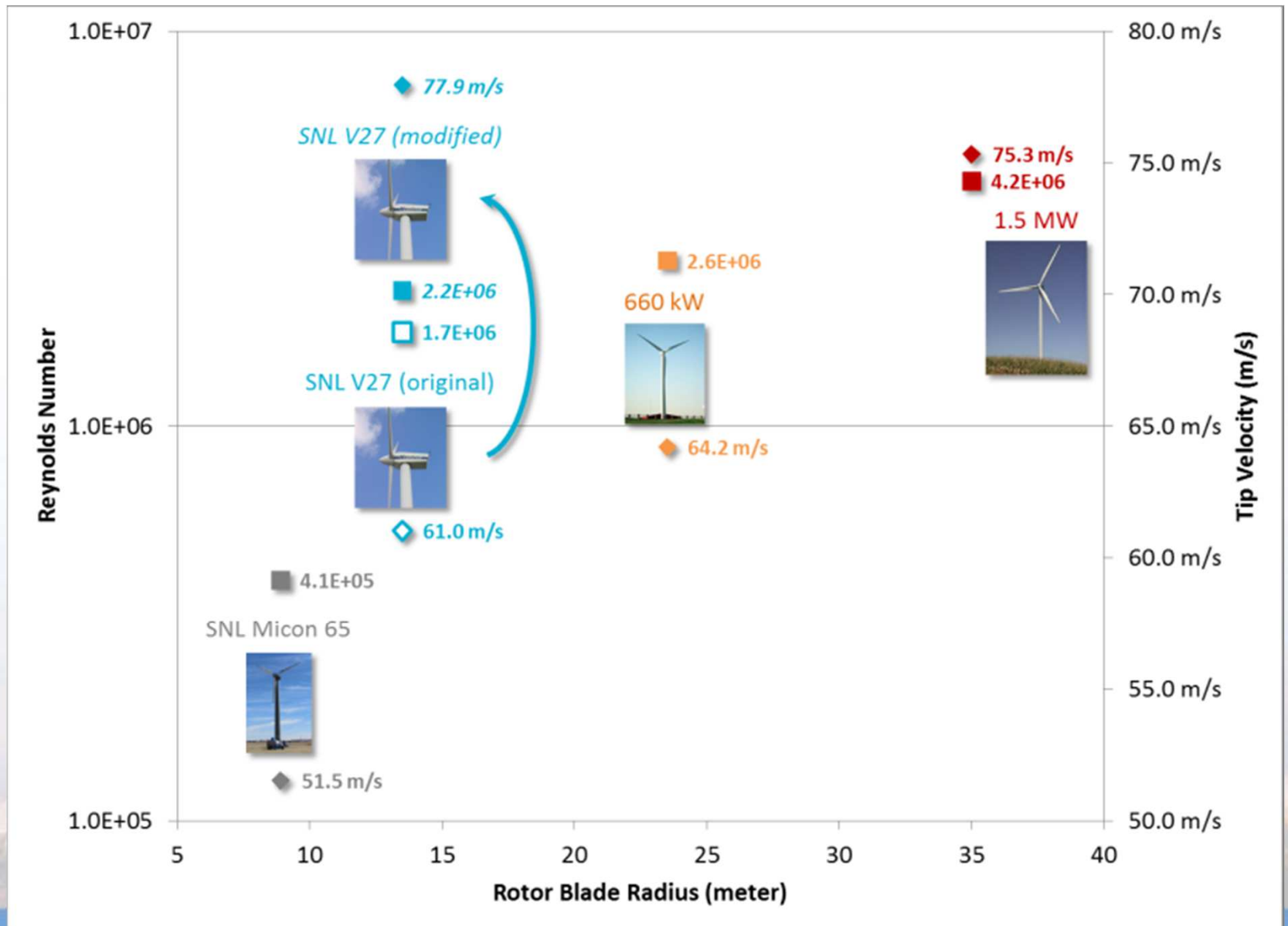


- A cost-efficient size for which research can be directly scaled to larger, more costly and time-consuming sizes.
- Requirements:
  - Operation at Reynolds Number (scaling parameter) between  $10^6$  and  $10^7$
  - Tip speeds approaching 80 m/s for acoustics and large rotor projects
  - Variable-speed variable-pitch operation
  - Minimal cost and time associated with research operations
  - Highly reliable turbine
  - Minimal restrictions on publication and intellectual property

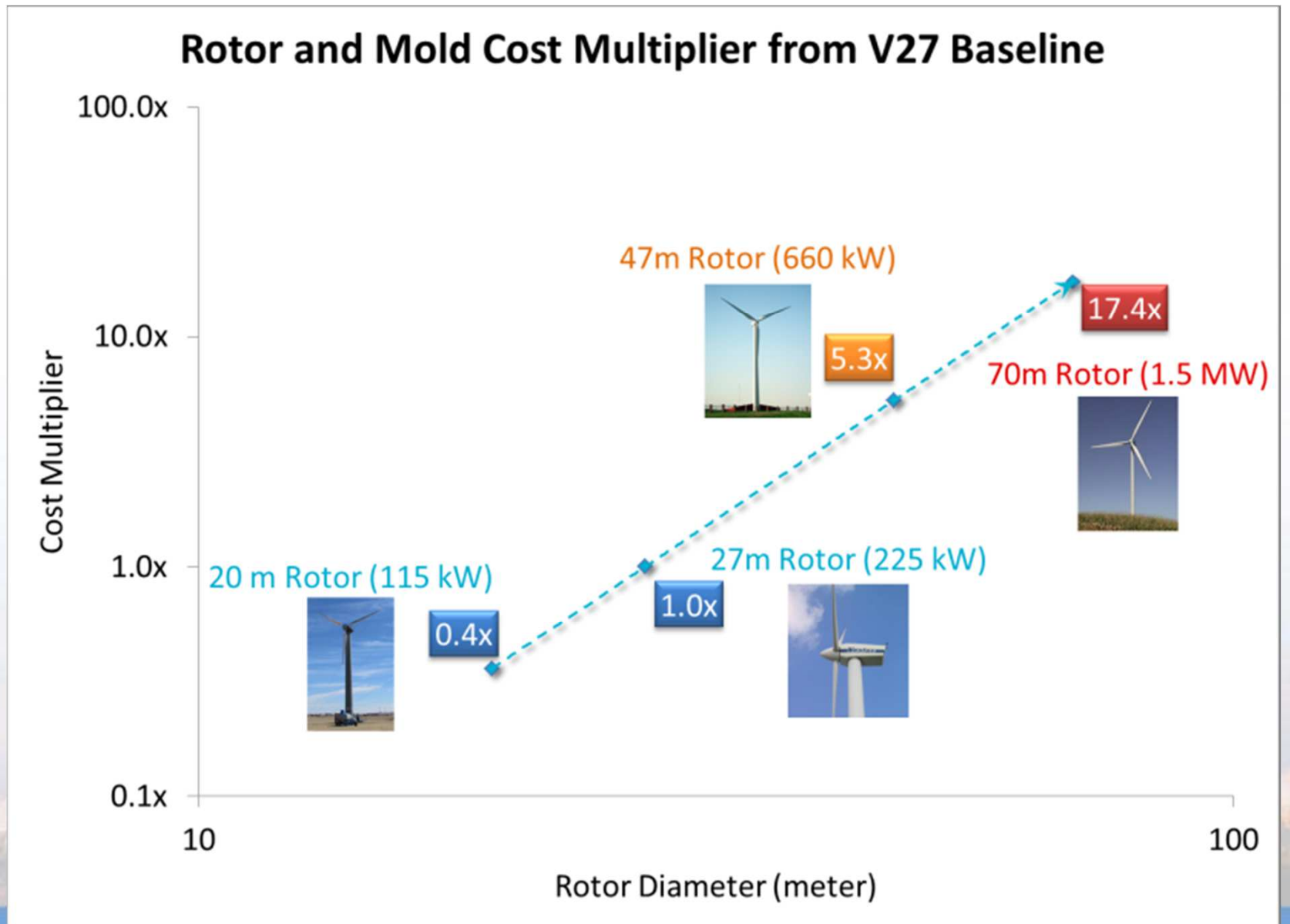


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# Aerodynamic Scaling



# Cost Efficiency



# Crane Cost Comparison

## Research Scale (225 kW)



Costs  
\$5,000 v. \$250,000

Scheduling  
Days Ahead v. Months Ahead

Testing Risk  
Low v. High

## Megawatt Scale



Technical data LR 1400/2	
Max. lifting capacity	1400 t
Max. lifting height	130 m
Max. reach	130 m
Center of gravity (height)	130 m
Truck axle	7.0 m
Max. superstructure height	130 m
Max. crane height	130 m
Max. crane height	130 m



# National Open-Source Research Asset

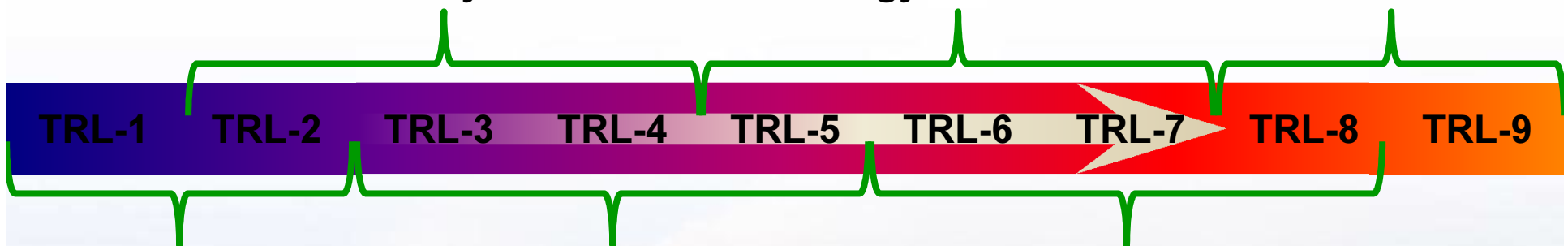
*DOE / SNL Rotor Blade  
Designs*



*DOE / SNL  
FAST / ADAMS  
Model of V27*

**Feasibility Proof**

**Technology Demonstration Commercialization**



**Basic Research**

**Technology Development**

**Sub-Scale Testing**



*DOE / SNL Advanced Blade  
Testing at NREL-NWTC*



*DOE / SNL  
SWIFT  
Facility  
at TTU*



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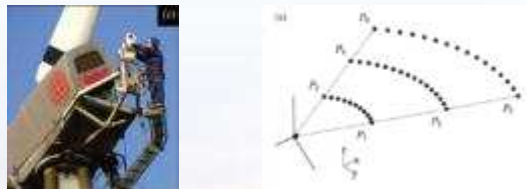
# Research-Scale Examples of Success



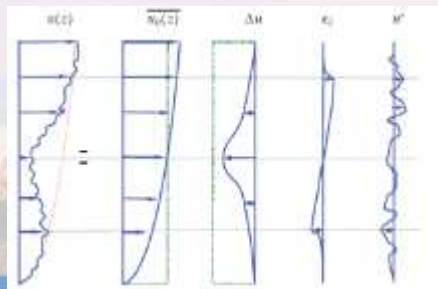
- “Light detection and ranging measurements of wake dynamic Part I & II” 2011



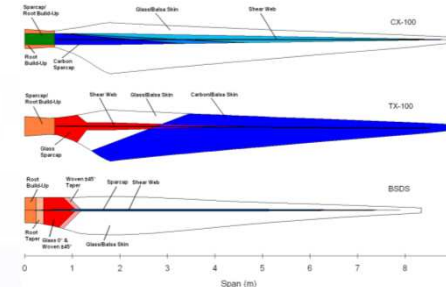
LIDAR Scanning of 95 kW Turbine Wake



Decomposition of Wake Deficit



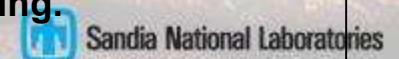
- CX / TX / BSDS Blade Family Study



Fabrication and Testing at the 115 kW Scale



Result: **24% reduction in damage equivalent load and initiated industrial use of carbon, flatback airfoils and twist-bend coupling.**





# ***Development Partnerships***

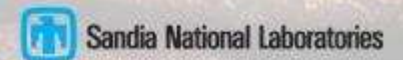


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# SWIFT Partnerships



U.S. DEPARTMENT OF  
**ENERGY**



# DOE/SNL/TTU Partnership

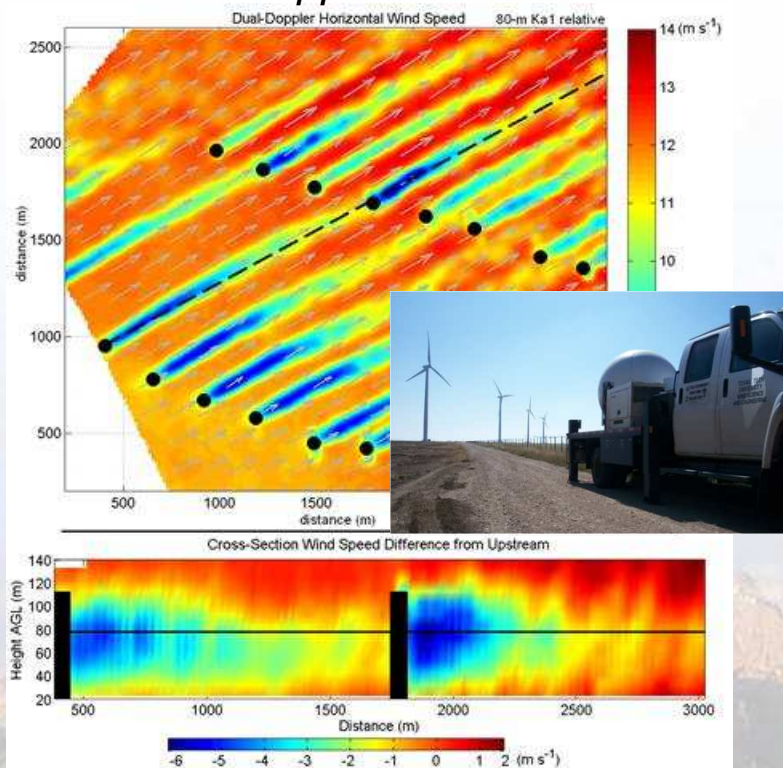
- *Wind Science and Engineering Research Center (WISE) has a 40 year history in wind-related research and development*
- *Unique Capabilities and Facilities*



TEXAS TECH  
UNIVERSITY.

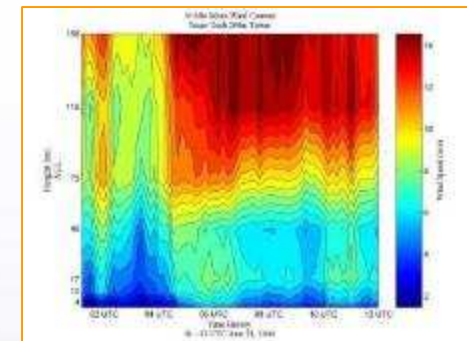
## Distributed Wind Resource Assessment

*2x mobile Doppler research radars*



## Large-scale Test Infrastructure

*200 meter anemometer tower*



*MW Wind Turbines*

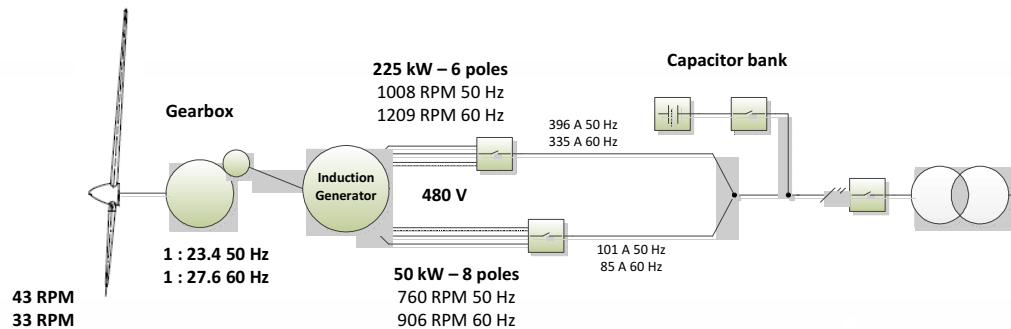


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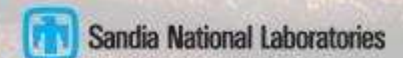
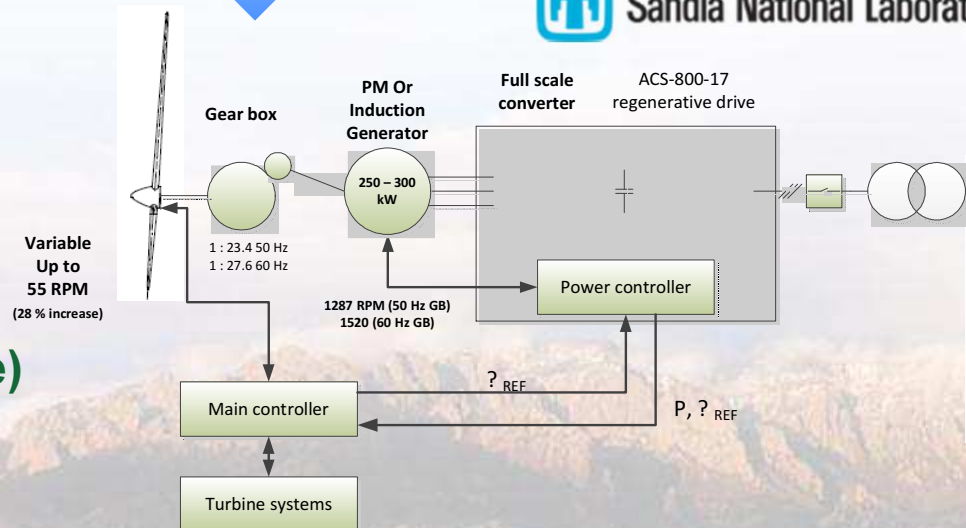


# Variable-Speed Upgrade

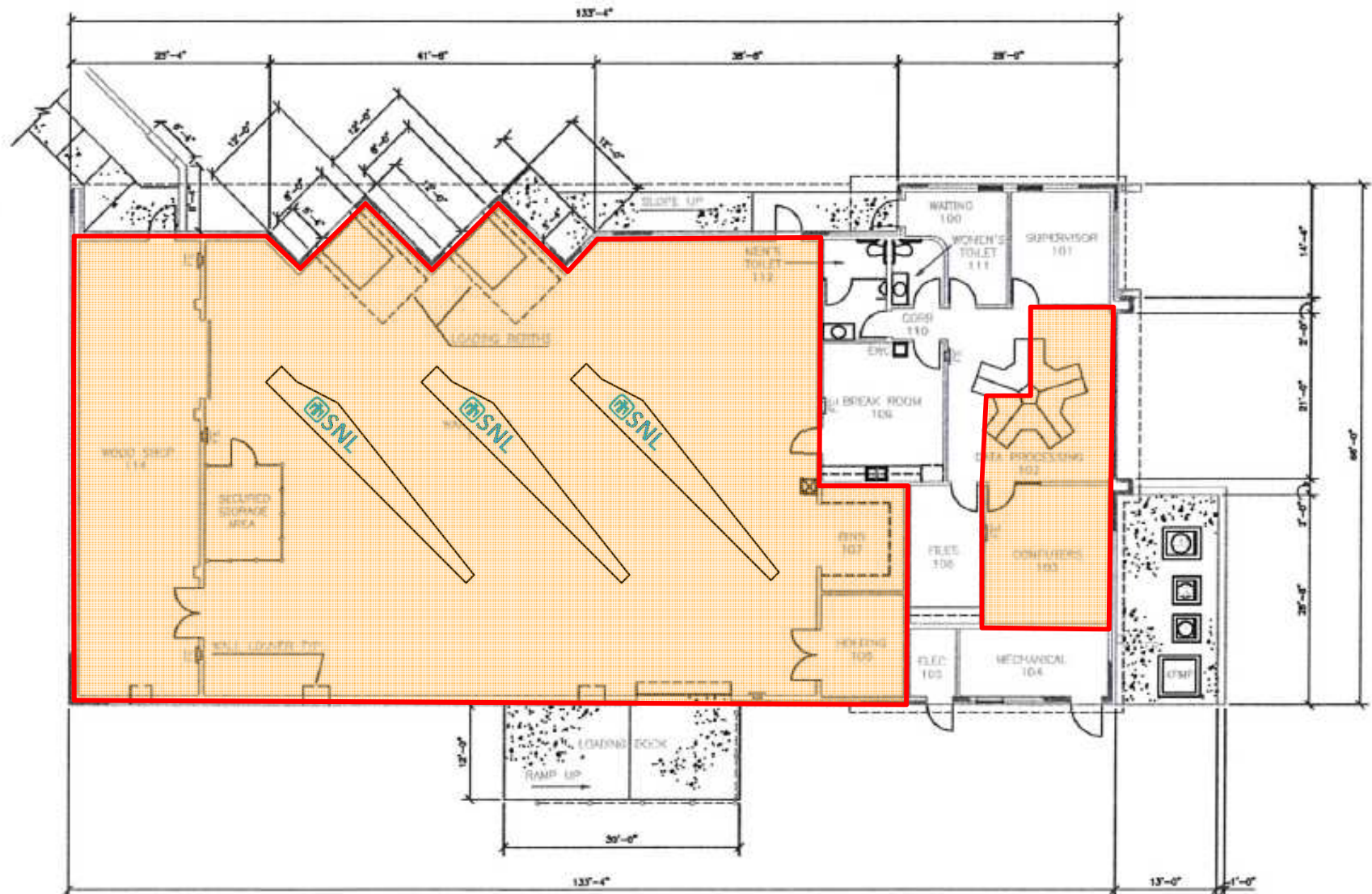
**Fixed  
Speed**



**DOE/SNL  
Variable  
Speed  
(Open-source)**



# Re-purposed Assembly Building





# ***Progress Updates***



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# Site Construction





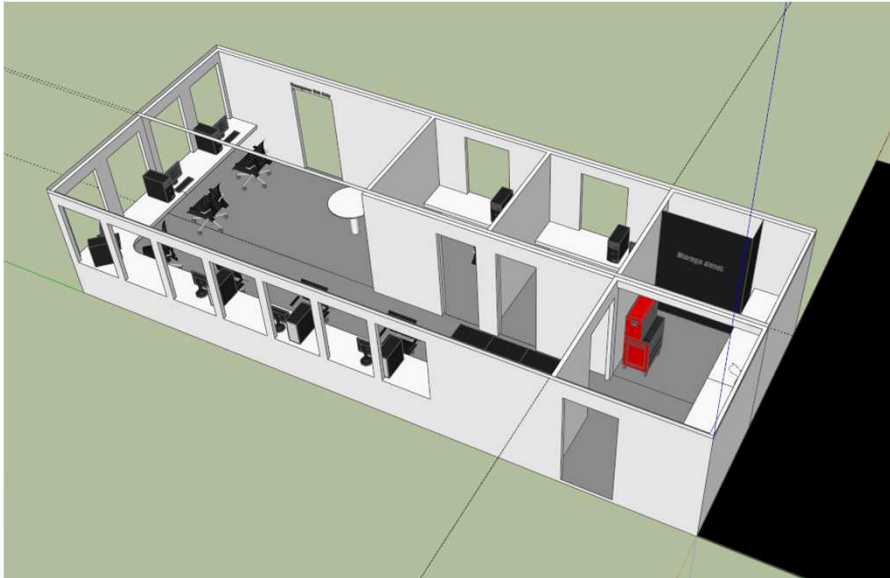
***SWiFT***



# ***Anemometer Tower***



# ***Control Building***



# ***Refurbished Assembly Building***



**Experimental rotor preparation**



**Machine Shop**

